HANDLING EMPTY APPLE BOXES

in

Pacific Northwest Packing and Storage Houses

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Marketing Service

Marketing Research Report No. 71 **Washington, D. C. June 1954**

For sale by Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. - - Price 30 cents

This is the third of five reports to be published by the Agricultural Marketing Service from data submitted by the Washington State Apple Commission in fulfillment of its contract with the U. S. Department of Agriculture. The first two reports are Marketing Research Report No. 49 "Apple Handling Methods and Equipment in Pacific Northwest Apple Packing and Storage Houses," and Marketing Research Report No. 68 "Innovations in Apple Handling Methods and Equipment." The other reports are expected to cover: (1) The effect of apple handling methods on storage space utilization, and (2) plantwide materials-handling costs. After these reports are issued, a summary is planned.

"Methods and Costs of Loading Apples in the Orchard in the Pacific Northwest," Marketing Research Report No. 55, published by the Agricultural Research Service of the Department in January 1954, summarizes another phase of the study.

Some of the results of this research are available now in summary form through the U. S. Department of Agriculture film entitled "Apple Handling Methods." A print of this film may be obtained on a loan basis from:

Visual Aids Service
University of Illinois
713½ South Wright Street
Champaign, Ill.

ACKNOWLEDGMENTS

The research on which this report is based was conducted by the Washington State Apple Commission's Research Department under a contract with the United States Department of Agriculture. The contract was administered by William H. Elliott, Transportation and Facilities Branch, Marketing Research Division, Agricultural Marketing Service, U. S. Department of Agriculture. The study was made under authority of the Agricultural Marketing Act of 1946 (RMA, Title II).

Acknowledgment is made to Frederick C. Winter, associate professor of industrial engineering, Columbia University, and consulting industrial engineer, Transportation and Facilities Branch, for reviewing the manuscript and making many helpful suggestions.

The authors express their appreciation to the operators of apple storage and packing plants in the State of Washington, who made their facilities available and otherwise gave assistance; and to the manufacturers and distributors of supplies and equipment, who cooperated in the research.

Credit is due Earl W. Carlsen, who supervised the research, and the other employees of the Research Department, Washington State Apple Commission, who gave valuable service in assembling and analyzing data and preparing the report, as follows: William C. Dower, Walter E. Nelson, and Clarence H. Engberg.

CONTENTS

SUMMARY

Methods and equipment for moving and handling empty apple boxes at storage houses in Washington State were studied to provide a guide to the industry in utilizing the practices that are most efficient and least expensive. Handling of empty boxes accounts for a substantial part of the costs of the apple storage operation.

Moving empty apple boxes from storage and loading them on road trucks or orchard trailers is accomplished in three ways: Manually, or by using clamp-type 2-wheel hand trucks, or by using industrial fork-lift trucks and pallets. In the manual operation, boxes are moved out of box houses and loaded on trucks. By the other two methods, boxes are moved from storage points inside the warehouse.

When the manual method is used, 2.99 man-hours of labor per 1,000 empty boxes are required. Labor and equipment costs by this method are $3.44 per 1,000 empty boxes, which is the highest cost of the three methods tested in this study.

Clamp-type 2-wheel hand trucks provide the least expensive method for placing boxes on road trucks and orchard trailers. Costs by this method are $1.35 per 1,000 empty boxes. These costs relatively are low because the hand trucks can handle 18-box unit loads and incur very low cost for equipment.

Industrial fork-lift trucks and pallets are relatively efficient for this operation, requiring only 0.80 man-hour of labor per 1,000 empty boxes. However, equipment costs are high, amounting to $1.20 per 1,000 empty boxes. Combined labor and equipment costs of this method total $2.24, or $0.89 higher than the method using the 2-wheel hand truck.

Four combinations of equipment are used for moving empty boxes from storage to the packing line: (1) Clamp-type 2-wheel hand truck and monorail conveyor; (2) industrial fork-lift truck, pallets, and monorail conveyor; (3) clamp-type 2-wheel hand truck and gravity roller conveyor; and (4) industrial fork-lift truck, pallets, and gravity roller conveyor. Labor requirements by the 2 hand truck methods--(1) and (3)--are the same, 1.96 man-hours per 1,000 empty boxes. The 2 methods utilizing fork-lift trucks and pallets--(2) and (4)--also are the same, 1.65 man-hours. Total costs for labor and equipment are highest for the fork-lift truck in combination with the monorail conveyor, and lowest for the clamp-type 2-wheel hand truck in combination with the gravity wheel conveyor.

Of the 3 methods used to move empty containers from the dumping area at the beginning of the washing and packing line to storage, 1 is paced by the rate at which the boxes are emptied of their fruit--about 300 boxes per hour per line. This method involves the use of belt conveyors in combination with clamp-type 2-wheel hand trucks. When this operation is

performed by the other 2 methods, which utilize hand trucks alone and fork-lift trucks and pallets, it is assumed that the workers and equipment are shifted to other duties when boxes are not available for handling.

Only 0.50 man-hour of labor is required to move 1,000 empty boxes from the dumping area to storage by an industrial fork-lift truck. To perform these operations by belt conveyors and hand trucks, 2.40 man-hours of labor are required. But, in spite of the superior ability of the industrial fork-lift truck in keeping labor costs down, the use of clamp-type 2-wheel hand trucks alone shows a cost of $1.79 per 1,000 empty boxes for labor and equipment, or $0.68 less than for fork-lift trucks. Costs for the method using belt conveyors and hand trucks total $3.66 per 1,000 boxes.

At packing and storage houses where field boxes are used, empty boxes usually are moved from the dumping area to storage by road trucks or orchard trailers. These boxes are moved from the dumping area onto the road trucks or orchard trailers by hand trucks. The loaded trucks or trailers are driven to the storage point where the empty boxes are removed manually and placed in box houses. Exclusive of driving time between packinghouse and box-house storage point and the cost of operating the road truck or orchard trailer, this method requires 4.49 man-hours of labor per 1,000 empty boxes and costs $5.18 for labor and equipment.

Labor and equipment costs per 1,000 empty boxes for performing the 3 cycles of operations--moving empty boxes from storage to road trucks or orchard trailers, moving empty boxes from storage to the packing line, and moving boxes from dumping area to storage--by use of the 3 principal types or combinations of types of equipment are as follows:

Type of equipment and method	Costs Dollars
Manual handling and clamp-type 2-wheel hand truck. .	11.63
Clamp-type 2-wheel hand truck.	6.15
Industrial fork-lift truck and pallets	8.22

At higher wage rates than those used in computing these costs, the advantage of the clamp-type 2-wheel hand truck decreases. At a wage rate of $0.25 per hour above the current rate, the difference in cost between this method and that using fork-lift trucks is reduced from $2.07, when current wage rates are used, to $1.65 per 1,000 empty boxes handled.

HANDLING EMPTY APPLE BOXES IN PACIFIC NORTHWEST PACKING AND STORAGE HOUSES

By D. Loyd Hunter, industrial engineer
Raoul S. Duerden, industrial engineer
Francis Kafer, research analyst
Washington State Apple Commission

and

Joseph F. Herrick, Jr., agricultural economist
Transportation and Facilities Branch
Marketing Research Division
Agricultural Marketing Service

INTRODUCTION

Millions of boxes and other containers are used each year to market the Nation's apple crop. As apples for the fresh market seldom are handled in bulk, some of these boxes are used to handle the fruit all the way from the orchard through the packinghouse and on through the terminal market. These boxes, as well as cartons and baskets, must be handled many times before they are packed with apples and transported to consuming areas.

In Washington State where about 40 million boxes of loose or unpacked apples are harvested each year, an equivalent number of empty containers must be handled between packinghouse storage areas and the orchard. As most of this fruit moves directly from the orchards into storage, for precooling before packing, boxes generally are used only once during the season to bring fruit from the orchard. The standard Northwest apple box used for moving packed fruit to terminal markets also is used as a field container.

Empty boxes are hauled first from storage to the orchard by road trucks or trailers. These boxes usually are stored in large outdoor box piles or box houses (fig. 1). The houses are constructed during or at the end of the previous packing season as boxes are emptied in the packinghouse or made by boxmakers. Some empty boxes are stored in packinghouse cold-storage rooms after the fruit has been shipped out (fig. 2).

At the orchard these boxes are scattered about under the fully laden trees. After the boxes are filled, they are hauled to the warehouse and placed in storage. Later in the season they are moved to the packing line. After the apples are dumped in the washer the empty boxes are sent either to the packing line to be used as containers for packed fruit or, in the case of old standard boxes and field boxes, are returned to box houses or storage rooms. Although much of the work of handling empty containers, other than that required during the harvesting and packing seasons, can be done during periods when speed is not one of the primary considerations,

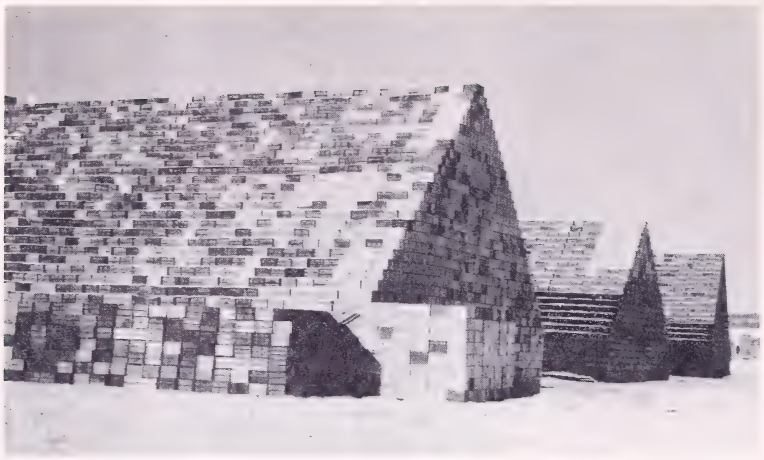

Figure 1.--Empty boxes stored in houses at apple packing plant.

Figure 2.--Pallet loads, each containing 72 empty apple boxes, stored in cold-storage room.

as when fruit is being moved into storage, these handlings are necessary and constitute one of the significant items of cost to plant operators.

Although a number of different types of containers are used for handling apples, the standard Northwest apple box is the principal container used in Washington State. Cartons, which generally come flat or knocked down, usually are handled with other supplies as part of the packing operation. Therefore, in the sections that follow only the standard apple box and field box are considered.

The standard apple box is used both for picking and as a shipping container. But, if it becomes weatherbeaten, soiled, or otherwise damaged in the course of its use as a field box, it will quite likely serve only in shuttling back and forth between the packinghouse and the orchard.

The standard apple box has inside dimensions of $10\frac{1}{2}$ by $11\frac{1}{2}$ by 18 inches. It is made of shook 9/32 of an inch thick on the sides and 11/16 of an inch on the ends (fig. 3). The bottom is made of thinner shook. The field box has the same inside dimensions as the standard box but the bottom and ends are made of thicker material and the corners are reinforced with corner posts (fig. 4). In the operations discussed in this report, all empty boxes are handled without tops.

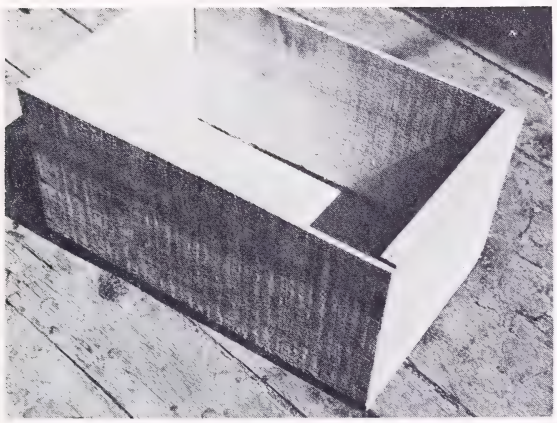

Figure 3.--Standard apple box.

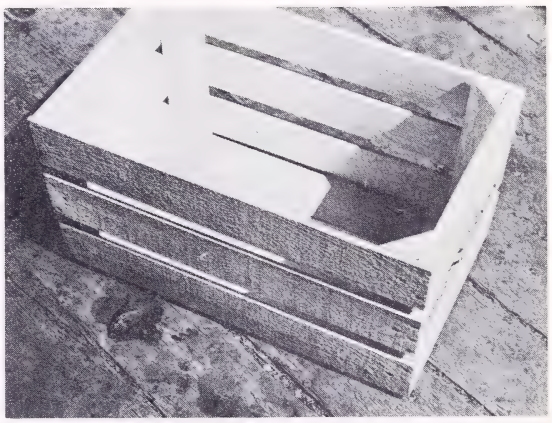

Figure 4.--Field apple box.

By most handling methods, empty standard and field boxes are nested or built into 3-box units by placing 1 box inside of 2 boxes that are fitted together. (Illustrations are shown in some of the figures of handling operations.) Nesting the boxes permits 3 boxes to be handled as a unit, and in storage 3 boxes occupy the space of 2.

The study on which this report is based was undertaken to develop methods for increasing the productivity of workers employed in apple packing and storage houses to handle empty containers. The comparative efficiency of various methods and types or combinations of types of materials-handling equipment, currently used in Washington State apple houses for performing the different operations, was measured under variable conditions of significance to the industry.

Although this study was made in Washington State, the data should be applicable to commercial (nonfarm) apple houses in other areas. If adjusted and interpolated these data also may be applicable to operations in farm storages which usually are of smaller capacity.

Time studies of handling operations of empty boxes, as performed by the use of various methods and types of equipment, were made at selected plants to determine: (1) The elapsed time required to handle given volumes of boxes; (2) the total man-hours of labor required; (3) the total machine-hours of equipment use; and (4) the causes and magnitude of delays, wait time, and other unproductive time occurring during the performance of these operations. Elapsed times were determined to provide a basis for comparing the speeds at which identifiable operations are performed by the use of various methods, and for computing labor and equipment inputs. Labor and equipment inputs provide at least one basis for comparing the relative efficiency of methods used for performing an operation. Standard data on labor requirements per 1,000 empty boxes for identifiable operations are shown in the Appendix. These data were compiled through time studies of actual operations.

Data on prevailing wage rates in Washington State apple plants during the 1951-52 season were obtained through interviews with plant managers, labor union officials, and others. Based on these data, a wage rate of $1.15 per hour is assumed to be the average rate for unskilled workers and this rate is used in the sections that follow for computing labor costs under current conditions. As the operation of industrial lift trucks involves accuracy in judging distances, either when driving the truck in the cold room or when maneuvering it in crowded areas, packing plants usually pay operators of industrial trucks from $0.10 to $0.20 per hour more than they pay regular workers. A wage rate of $1.30 per hour is, therefore, assumed to be the average rate for semiskilled workers. This rate is used for computing labor costs under current conditions where semiskilled labor is employed.

Because of trends in wage rates, cost comparisons made by use of current wage rates may not adequately reflect the comparative efficiency of various methods and types of equipment during some future period. Therefore, to show cost relationships if wages should be increased further, an increase of $0.25 per hour was made in current rates both for unskilled and semiskilled workers. Wage rates under these assumed conditions would be $1.40 per hour for unskilled workers and $1.55 per hour for semiskilled workers. These rates are used in the sections that follow for computing labor costs under assumed conditions. 1/

The costs of ownership and operation of various types of materials-handling equipment, which have been used for computing total equipment costs for performing handling operations, were obtained through accounting

---

1/ For a more complete discussion of wage rates, see "Apple Handling Methods and Equipment in Pacific Northwest Packing and Storage Houses," Marketing Research Report No. 49, U. S. Dept. of Agr., Prod. and Mktg. Adm., June 1953.

analyses made in selected plants and through cost records maintained on special forms by cooperating plant operators. Other data were obtained through surveys of equipment manufacturers, insurance companies, and tax officials. Combined hourly costs of ownership and operation of selected types of equipment used for handling empty boxes are shown in table 1.

Table 1.--Estimated costs of ownership and operation of specified types of materials-handling equipment used for handling empty containers in Washington State apple-packing and -storage plants, 1952 1/

Type of equipment	Amount of equipment	Replacement cost	Assumed annual use	Cost of ownership		Cost of operation	Total cost per hour
				Per year	Per hour	Per hour	
	Unit	Dollars	Hours	Dollars	Dollars	Dollars	Dollars
Clamp-type 2-wheel hand trucks	1	74.10	2/ 400	3/ 7.03	0.017	0.007	0.024
Belt conveyor	75 feet	1,200.00	4/ 675	3/ 114.00	.17	.095	.265
Gravity wheel conveyor	100 feet	385.00	4/ 675	5/ 41.99	.062	.013	.075
Monorail conveyor	100 feet	430.00	4/ 675	5/ 48.02	.072	.028	.100
Industrial fork-lift truck (4,000-pound capacity--electric)	1	7,271.00	2/ 400	6/ 807.16	2.02	.26	2.28
Pallets (40- by 48-inch)	7/ 20.8	62.70	8/ 3.64	5/ 7.02	1.92	.10	2.02

1/ For additional details and other types of equipment, see "Apple Handling Methods and Equipment in Pacific Northwest Packing and Storage Houses," Marketing Research Report No. 49, U. S. Dept. Agr., PMA, June 1953.
2/ Estimated hours that equipment is used annually.
3/ Based on 20-year depreciation period, interest on investment at 5 percent, and 2-percent allowance for insurance and taxes.
4/ Based on a packing period of 90 days at 7½ hours per day.
5/ Based on 15-year depreciation period, interest on investment at 5 percent, and 2-percent allowance for insurance and taxes.
6/ Based on 20-year depreciation period for chassis and 7½-year life of battery, interest on investment at 5 percent, and 2-percent allowance for insurance and taxes.
7/ This is the number of pallets required to handle 1,000 unpacked boxes of apples, 48 boxes per pallet.
8/ Based on the number of hours of labor required per 1,000 boxes in all groups or cycles of handling operations.

Labor and equipment costs for handling empty boxes by specified methods and types of equipment have been computed to provide a basis for comparing the relative efficiency of the several methods. These cost computations were necessary because comparisons cannot be made on the basis of physical inputs of labor and equipment; that is, man-hours of labor and machine-hours of equipment use cannot be totaled as a basis for making comparisons. Therefore, the labor and equipment inputs were converted to dollar costs and comparisons are between methods on the basis of combined costs for labor and equipment.

The 5 principal types of equipment used to handle empty containers are: (1) Clamp-type 2-wheel hand trucks; (2) belt conveyors; (3) gravity roller conveyors; (4) monorail conveyors; and (5) industrial fork-lift trucks and pallets. Manual handling methods also are used to perform some operations.

Clamp-type 2-wheel hand trucks probably outnumber all other types of equipment used for handling empty boxes (fig. 5). The clamp truck has two arms which grasp the boxes and clamp in from the sides when motivated by a foot-operated lever. By use of this equipment 18 empty boxes usually are picked up, transported, and released as a unit load (fig. 6).

Belt conveyors in apple packing and storage houses in the State of Washington usually are constructed of wood or metal frames, and have wood

Figure 5.--Clamp-type 2-wheel hand truck.

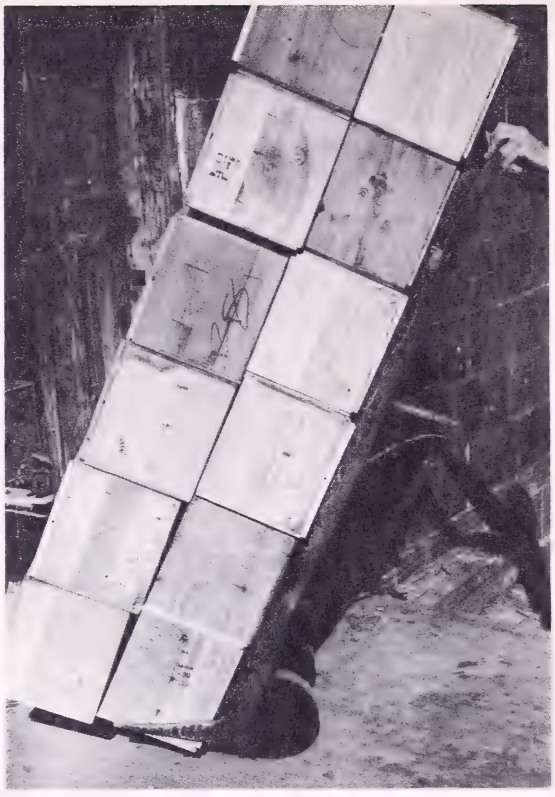

Figure 6.--The nesting of boxes--1 box placed inside of 2--makes it possible for a hand truck to hold a unit load that extends beyond the clamping arms.

or steel rollers, over which 12- to 14-inch belts are pulled to provide the conveying surface. When used for handling empty boxes, these conveyors are generally built to specifications required by plant conditions.

Gravity-type wheel conveyors also are used for handling empty boxes in some operations. The boxes roll on small diameter wheels mounted several inches apart on two parallel metal rails. In general, this type of conveyor is used to move empty boxes from the dumping area to the packing stations.

A monorail conveyor system is comprised of an endless overhead chain conveyor equipped with hooks or carriers on which empty boxes are hooked for transporting them to the packing stations. This type of conveyor moves at a rate which permits boxes to be put on or taken off at any point along the route it serves. An advantage of the monorail system is that it

can be used to carry all types of empty containers to the packers. Monorail conveyors also are utilized to carry boxes to and from outside storage areas adjacent to the packinghouse.

Industrial fork-lift trucks used in the apple packing and storage houses are of the same general design as those used in other industries (fig. 7). They usually are equipped with 4-inch forks of sufficient length to handle the standard 40- by 48-inch and 36- by 40-inch pallets. Pallet loads of 72 empty standard boxes can be handled by this equipment.

Figure 7.--Industrial fork-lift truck.

Data were developed for the following cycles of operations: (1) Moving empty boxes out of storage and loading them on road trucks and orchard trailers; (2) moving empty boxes from storage to the packing line; (3) moving empty boxes from the dumping area, at the beginning of the washing and packing line, to storage; and (4) moving empty boxes from the dumping area to storage by road trucks and orchard trailers.

Before the harvest season, empty boxes are removed from storage piles and loaded on road trucks and orchard trailers for transit to the orchard. 2/ Various methods are used to load the boxes, all of which involve manual handling. In one of these methods, one worker hands boxes to another worker

---

2/ The number of boxes hauled by road trucks and orchard trailers varies, but generally the trailer hauls about as many boxes a trip as the road truck. The usual load is 432 boxes.

who in turn passes them along in "bucket brigade" fashion from the top or various parts of the box pile to a worker on the road truck or trailer who stows them in hauling position. Boxes also are loaded on road trucks and trailers from storage rooms or from small piles that are made by boxmakers. When the loading is by clamp-type 2-wheel hand trucks or by industrial fork-lift trucks, boxes are handled in 18- and 72-box units, respectively.

Only when fruit is moved to the packing line in field boxes or old standard boxes is it necessary to move empty standard boxes from storage to the packing line to supply the packers with the necessary new boxes. Boxes are moved to the packing line from storage by use of: (1) Overhead monorail conveyor alone; (2) industrial fork-lift trucks in combination with overhead monorail conveyors; (3) clamp-type 2-wheel hand trucks in combination with gravity wheel conveyors; or (4) fork-lift trucks in combination with gravity wheel conveyors.

After fruit is brought from storage to packing line and dumped, the "dumper" 3/in plants that do not use pallets generally places the new or clean boxes on a gravity conveyor or an overhead monorail conveyor which carries the boxes to the packers. Field boxes or old boxes are nested and stacked for hand trucking to storage. In plants that use pallets ("palletized" plants), empty boxes are handled in the same way as in unpalletized plants, except that the boxes are placed on pallets instead of in stacks and are removed by industrial fork-lift trucks. These boxes are stored in fruit storage rooms or in large open storage areas where they are held until the next harvest season.

The last cycle in handling operations of empty boxes involves the movement of boxes to storage by a road truck or orchard trailer. These operations are required when boxes are stacked in box houses some distance from the packing plant (fig. 1). Boxes are placed on the road truck or orchard trailer by an industrial fork-lift truck and pallets or clamp-type 2-wheel hand trucks. When boxes are unloaded into a box house for storage, the road truck backs up to the desired unloading position and the boxes are handed in 3-box units from one worker to another in a bucket brigade until they are placed in the correct position in the box house.

Methods of handling empty containers by clamp-type 2-wheel hand trucks and industrial fork-lift trucks are similar to methods used for handling boxes of fruit by this equipment. Obviously, the productive labor required

---

3/ The worker responsible for dumping the fruit from the boxes on the conveyor, which carries the fruit to the washing equipment, is called the "dumper." In some plants this dumping operation is performed automatically by a machine.

per 1,000 boxes differs considerably because both types of equipment carry a greater number of empty boxes than full ones. However, the productive labor on a per-trip basis was found to be so nearly alike for empty containers and loose-packed boxes that no significant difference could be detected. For this reason, the productive labor requirements, for handling empty boxes by use of hand trucks and fork-lift trucks, have been derived from the productive labor requirements for handling loose fruit by the same type of equipment (see Appendix).

Time studies were made of the various phases of handling empty containers and the data obtained were supplemented with data from ratio-delay studies. 4/ Ratio-delay studies were used to obtain averages over a longer period than would have been practicable by time study techniques and are, therefore, based on a much larger sample. 5/

No attempt is made in this report to determine the costs of handling empty tray-pack cartons and bonding-type cartons, as the work involved is done largely as a packing-room operation. Carton handling involves moving the stock of unassembled cartons from storage points into the packing room. When the cartons are brought as "flats" to the packing area, the packer forms the cartons just before packing apples in them. When cartons are set up before being brought to the packing area, a worker other than the packer forms the carton by stapling or gluing the bottom. The handling of the flat cartons within the packing room is not assigned a standard time as this task is usually performed by a worker who also does other miscellaneous jobs.

4/ The ratio-delay study (more recently called work sampling) refers to a method by which the relative time that equipment, materials, or personnel are in specified states in the course of an operation or process is estimated on the basis of a sample of random observations of the activity.

5/ Handling boxes was an integral part of ratio-delay studies, because empty boxes were frequently handled by workers from other work crews in the plant. Ratio-delay observations covered details of empty box handling, such as placing empty boxes on monorail, removing boxes from monorail, and waiting for work. Therefore, data on specific operations can be "broken out" and combined.

METHODS AND EQUIPMENT FOR MOVING EMPTY BOXES FROM STORAGE AND LOADING THEM ON ROAD TRUCKS AND ORCHARD TRAILERS

Empty boxes are commonly moved to and loaded on road trucks and orchard trailers from two types of storages--large box houses or regular cold-storage rooms that have been emptied of fruit (figs. 8 and 2). When box houses are being broken down, the roof of the house must be removed, broken boxes mended, and the nails in the roof boards removed (fig. 9). These operations are in addition to the loading of trucks and trailers. The roofs of box houses usually are made by overlapping boards of 1-inch lumber laid to make a "bat and board" roof. Occasionally box houses are not roofed, a practice that may not be advisable where precipitation is heavy and humidity high.

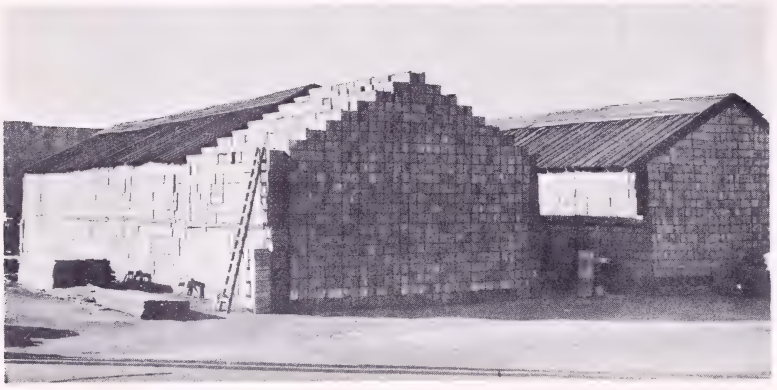

Figure 8.--Box house storage with roof at a commercial apple packing and storage plant.

A 2-day log kept of all the work performed at 1 box house showed that the actual loading of boxes on road trucks and orchard trailers required about 50 percent of the crew's time. Large crews are used for this operation because of the assignment of workers, hired in advance of the approaching warehouse receiving season, who are not needed at the time for other tasks.

Time required to load boxes from these houses on road trucks and orchard trailers may vary considerably because of the different methods used. For example, when boxes in the upper part of the box house are being loaded on the road truck, the 3-box units usually are handed down from one worker to another and then stacked by hand on the road truck bed. But, when boxes from the lower part of a house are being loaded on the truck, the 3-box units usually are handed by a worker on the ground to a worker on the road truck, who in turn places the boxes in position on the truck bed.

Figure 9.--Workers removing the roof from a box house.

When boxes are moved from a warehouse storage room and loaded on a road truck or orchard trailer by clamp-type 2-wheel hand trucks or industrial fork-lift trucks, they are carried in unit loads of 18 and 72 boxes, respectively. Although road truck and orchard trailer loads of empty boxes vary in the number of boxes, it is assumed for purposes of this analysis, that a truck or trailer load consists of 432 empty boxes.

Manual Method

The manual method of breaking out empty apple boxes from storage in box piles and loading them on road trucks or orchard trailers involves the lifting of 3-box units from the stack, handing or passing the units along for conveyance, and positioning them on the truck or trailer bed. Occasionally roller conveyors are used in the loading operation (fig. 10).

Because of variations in elapsed times required to load trucks and trailers when boxes are removed from different sections of box piles, establishing "standards" was found to be impractical. Therefore, average data are used as a basis for computing labor requirements.

The manual method illustrated in table 2 employs a 5-man crew. These workers take their respective positions on the box house and on the road

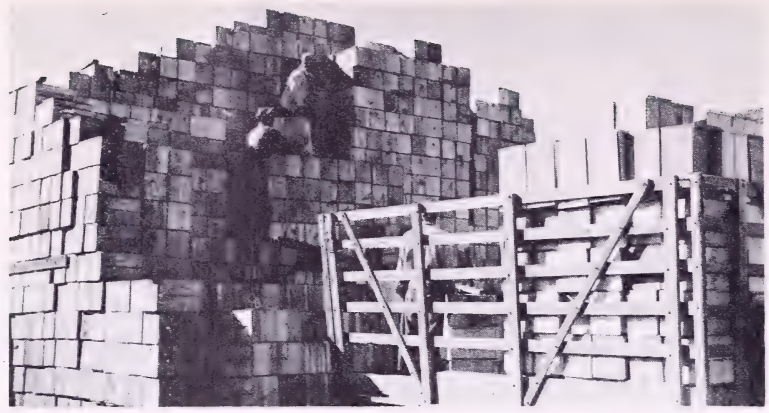

Figure 10.--Loading empty boxes on a road truck.

Table 2.--Labor required for a 5-man crew to remove manually 1,000 empty boxes from outdoor box storage piles and load them on road trucks and orchard trailers

Operation	Workers	Productive time	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours
Setup and cleanup	5	0.14	0.21	0.35
Remove roof of box house	5	.40	.0	.40
Manually load boxes by passing 3-box units from 1 worker to another until the empty boxes are stacked on the truck bed	5	1.95	1/ .29	2.24
Total man-hours	-	2.49	.50	2.99
Elapsed time				2/ .52

1/ Caused by crew interference.
2/ Elapsed time shown does not include time required for removing the roof of the box house.

truck or orchard trailer and pass the 3-box units along from one worker to another, until they reach the man on the truck. This worker places the 3-box units in position on the truck bed. Before boxes are broken out of a box house it is necessary to remove at least part of the roof. As additional boxes are removed, it is necessary to remove more of the roof.

As shown in table 2, 2.99 man-hours of labor are required for a crew of 5 workers to remove 1,000 empty boxes from a box house and load them on road trucks. Only 17 percent of the total labor is unproductive. At this rate, a load of 432 boxes can be removed from the box house and loaded on trucks or trailers in an elapsed time of 14 minutes.

Clamp-Type 2-Wheel Hand Truck

The distance that boxes are moved from storage rooms to road trucks or orchard trailers varies in each plant with each load. Crew sizes also vary in different plants. For purposes of this analysis, however, transportation distances are standardized at 100 feet and a 3-man crew is used. Eighteen boxes, in 3-box units stacked 6 boxes high, are moved as a unit load by clamp-type 2-wheel hand trucks (figs. 11 and 12). Because the clamp-type 2-wheel hand truck can handle a fairly large number of boxes at one time its efficiency is relatively high (fig. 6). As shown in table 3, a 3-man crew can remove 1,000 boxes from storage and load them on a motortruck with a labor input of 1.15 man-hours. The elapsed time is 10 minutes for a truckload of 432 boxes.

Figure 11.--Transporting 18 empty boxes by use of a clamp-type 2-wheel hand truck.

Figure 12.--Empty boxes being loaded on an orchard trailer by use of clamp-type 2-wheel hand truck.

Table 3.--Labor required for a 3-man crew to move 1,000 empty boxes from storage rooms and load them on road trucks or orchard trailers by clamp-type 2-wheel hand trucks

Operation	Workers	Productive time	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours
Setup and cleanup	3	0.14	0.07	0.21
Pick up 18-box loads by clamp-type 2-wheel hand trucks	3	.11	.0	.11
Transport 18 boxes 100 feet from storage to carrier by clamp-type 2-wheel hand trucks	3	.67	1/ .05	.72
Release 18-box loads on carrier bed by clamp-type 2-wheel hand trucks	3	.11	.0	.11
Total man-hours	-	1.03	.12	1.15
Elapsed time				.38

1/ Caused by crew interference.

Industrial Fork-Lift Truck and Pallets

During the packing season and at the end of the receiving season in plants using pallets and fork-lift trucks, empty boxes are placed on pallets and stored in vacant cold-storage rooms until the next harvest season (fig. 13). When boxes are moved out to the field again these pallet loads are taken from the storage room and placed on road trucks or orchard trailers by fork-lift trucks (fig. 14).

By a commonly used method, the fork-lift truck picks up pallet loads of 72 boxes each, transports them 100 feet from the storage room to the truck or trailer, and releases the pallet loads on the bed of the carrier. Use of this method, when a 2-man crew is used, requires only 0.80 man-hour of labor per 1,000 boxes (table 4). By this method a road truck or orchard trailer load of 432 boxes is loaded in an elapsed time of 12 minutes.

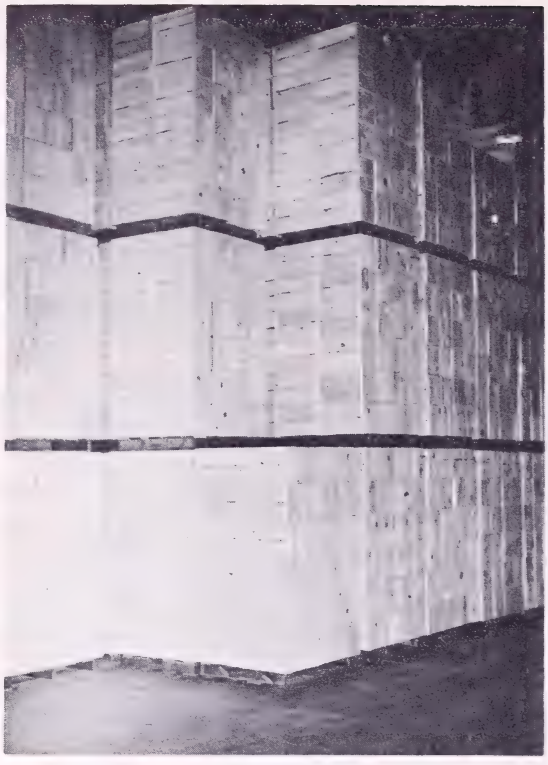

Figure 13.--New boxes stacked on pallets in a cold-storage room and ready to be moved to the orchard.

Table 4.--Labor required for a 2-man crew to move 1,000 empty boxes out of storage rooms of plant and load them on road trucks or orchard trailers by pallets and industrial fork-lift trucks

Operation	Workers	Productive time	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours
Setup and cleanup	1	0.14	1/ 0.33	0.47
Pick up pallet load (72 boxes) of empty boxes in storage room by fork-lift truck	1	.06	.0	.06
Transport pallet load 100 feet from storage to carrier by fork-lift truck	1	.20	.0	.20
Release load from fork-lift truck on carrier bed	1	.07	.0	.07
Total man-hours	-	.47	.33	.80
Elapsed time				.47

1/ Worker waits during handling by fork-lift truck.

Figure 14.--Transporting 72 empty boxes on a pallet from storage room to road truck by fork-lift truck.

Comparison of Methods and Types of Equipment for Moving Empty Boxes from Storage and Loading Them on Road Trucks or Orchard Trailers

Comparative labor and equipment costs for moving 1,000 empty boxes from storage and loading them on road trucks and orchard trailers by the 3 methods discussed are shown in table 5. The first 2 of these methods, which involve loading manually and by clamp-type 2-wheel hand trucks, cover the moving of empty boxes from box piles and storage rooms and loading them on road trucks or orchard trailers, and are typical of the methods used in conventional-type plants. The fork-lift truck and pallet method involves moving empty boxes from cold-storage rooms of the plant to the road truck. As a rule, plants that use fork-lift trucks do not store empty boxes in outdoor box piles.

Although these methods are not strictly comparable because of differences in storage conditions, manual loading from box piles shows the greatest costs. The most economical method of moving empty boxes out of storage is by use of the clamp-type 2-wheel hand truck. The fork-lift truck and pallet method requires an expenditure of $2.24 to move 1,000 empty boxes out of storage--$0.89 per 1,000 empty boxes more than the hand-truck method. But, if a plant uses fork-lift trucks for fruit-handling operations and has no hand trucks, the low labor cost of moving boxes by industrial trucks would make it desirable to use this equipment.

Table 5.--Comparative labor and equipment costs for moving 1,000 empty boxes from storage and loading them on road trucks and orchard trailers, by 3 specified methods

Method	Elapsed time	Labor and equipment required		Labor and equipment costs			
		Equipment time	Total labor	Equipment	Labor 1/	Total cost	
						Current wages	Assumed wages
	Hours	Machine-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Manual loading boxes from box pile	0.52	0.0	2.99	0.0	3.44	3.44	4.19
3 workers hand-truck stacks (18 boxes) 100 feet from storage room	.38	2/ 1.15	1.15	.03	1.32	1.35	1.64
1 fork-lift truck moves pallet loads of 72 boxes from storage room	.47	3/ .66	.80	4/ 1.20	1.04	2.24	2.44

1/ Computed from current wage rates.
2/ Clamp-type 2-wheel hand truck only.
3/ 4,000-pound capacity electric industrial fork-lift truck requiring 0.33 machine-hour and 13.9 pallets, 40- by 48-inch, requiring 0.33 machine-hour, or a total of 0.66 machine-hour. Does not include setup and cleanup time.
4/ Calculated as follows: 0.33 machine-hour x $2.28 + 0.33 machine-hour x $1.35 (hourly cost per 13.9 pallets) = $1.20.

METHODS AND EQUIPMENT FOR MOVING EMPTY BOXES FROM STORAGE TO THE PACKING LINE

As most of the apple packing plants in Washington State use new standard boxes as field boxes, fruit is packed in these boxes after loose fruit has been dumped from them (figs. 15 and 16). Therefore, at some plants empty boxes seldom are moved from storage to the packing line. However, plants that pack apples in cartons and plants that store loose fruit in old boxes or field containers but pack the fruit for market in new boxes, must move the cartons or new boxes from storage to the packing line. Because cartons are handled as flats in the storage room and not as made-up boxes, they are considered to be packing supplies and, as mentioned earlier, the handling methods used are not covered in this report.

Figure 15.--After the worker dumps fruit from new standard boxes, the empty boxes are placed on a roller conveyor which carries them to the packing stations.

Plants in which new wooden boxes are moved from storage to the packing line use hand trucks or fork-lift trucks in combination either with monorail conveyors or wheel conveyors for this cycle of operations.

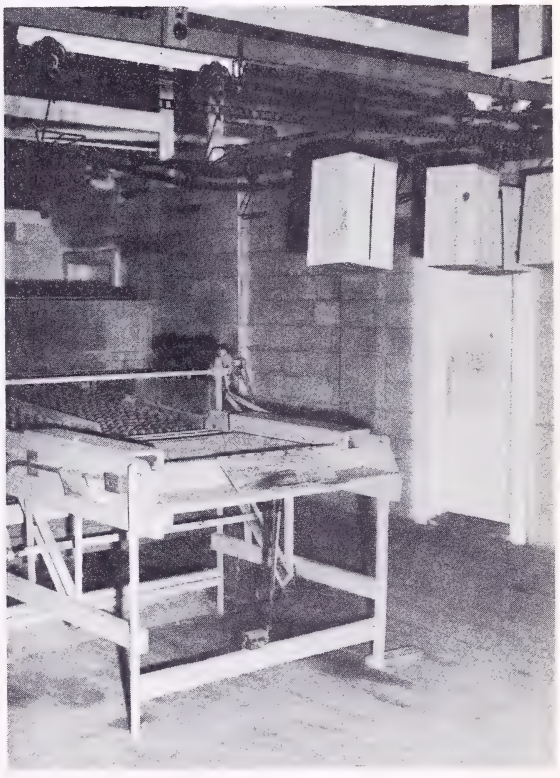

Figure 16.--A dumping station at which the worker who dumps the fruit hangs the empty boxes on an overhead monorail conveyor.

The rate at which the fruit is dumped into the washer determines the rate at which boxes are to be brought to the packing line. This rate usually approximates 250 to 300 boxes per hour. Because of this relatively slow pace, workers assigned to the task usually fill in some of their time by doing other work. When these workers cannot be assigned to other tasks, considerable wait time results. Variations in the rate at which boxes must be supplied to the packing line, depending on the size of fruit being run, the number of

sorters, the number of packers, and the number of sizing tubs on the packing line, also influence this wait time. For purposes of analysis, it is assumed that 210 empty boxes are delivered to the packing line per hour over a transportation distance of 50 feet.

Clamp-Type 2-Wheel Hand Truck and Monorail Conveyor

The method commonly used to move empty boxes from storage to the packing line by use of 2-wheel hand trucks and monorail conveyor, utilizes one man to truck the empty boxes in 18-box loads to a bank near a monorail conveyor where the load is released. This worker then hangs the empty boxes from the stack on the hooks of the monorail conveyor (fig. 17).

Figure 17.--A worker hanging empty boxes from a bank on the hooks of a monorail conveyor.

When a worker is assigned full time to this task and only one line is supplied by the monorail conveyor, considerable wait time results. In table 6, which shows the labor required for this particular method, it is assumed that the worker is also assigned other tasks. Therefore, only that part of his time required to do the productive work involved is shown.

Use of this method requires 1.96 man-hours of labor to hand truck 1,000 boxes from a storage position and place them on the monorail conveyor. As a plant that dumps apples at a rate of 300 boxes per line per hour requires only 210 empty boxes per hour for packing operations

Table 6.--Labor required for 1 worker to move 1,000 empty boxes from storage to the packing line by clamp-type 2-wheel hand truck and monorail conveyor

Operation	Workers	Productive time	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours
Pick up 18-box loads in storage area by clamp-type 2-wheel hand truck (crowded area)	1	0.11	0.0	0.11
Transport 18-box loads 50 feet from temporary storage to monorail conveyor by clamp-type 2-wheel hand truck	1	.35	.0	.35
Release 18-box loads at monorail conveyor by clamp-type 2-wheel hand truck (open area)	1	.09	.0	.09
Remove new boxes from bank and hang on hooks of monorail conveyor	1	1.41	.0	1.41
Total man-hours	-	1.96	.0	1.96

the worker who trucks the boxes and hangs them on a conveyor has more than one-half of his time available for other jobs.

Industrial Fork-Lift Truck, Pallets, and Monorail Conveyor

In the method using fork-lift trucks, 72-box pallet loads are picked up in the storage area, transported a distance of 50 feet from storage position to a location near the monorail conveyor, and released. At this point a second worker transfers the boxes from the pallets to the monorail conveyor. Because considerable extra time is available it is assumed that both workers are assigned to other jobs when not productively engaged in these operations.

Table 7.--Labor required for a 2-man crew to move 1,000 empty boxes from storage to the packing line by industrial fork-lift truck, pallets, and monorail conveyor

Operation	Workers	Productive time	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours
Pick up 72-box pallet load of empty boxes in storage area, by fork-lift truck	1	0.06	0.0	0.06
Transport 72-box load 50 feet from temporary storage to monorail conveyor, by fork-lift truck	1	.15	.0	.15
Release 72-box load at monorail conveyor, by fork-lift truck	1	.03	.0	.03
Remove new boxes from pallet and hang them on hooks of monorail conveyor	1	1.41	.0	1.41
Total man-hours	-	1.65	.0	1.65

When a fork-lift truck is used in combination with a monorail conveyor for moving empty boxes from the storage point to the packing line, 1.65 man-hours of labor are required per 1,000 boxes, which is 0.31 man-hour less than the time required to do the job with 2-wheel hand trucks (table 7).

Clamp-Type 2-Wheel Hand Trucks or Industrial Fork-Lift Trucks and Pallets, and Wheel Conveyors

Although monorail conveyors are used in some plants to move empty boxes to the packers, gravity-type wheel conveyors are more commonly used for this purpose. Wheel conveyors extend from a point outside the packing room, where empty boxes are placed on them, into the room alongside the packing stations. Packers remove empty boxes from the conveyor line as needed.

Under comparable conditions, and when used in combination with hand trucks or fork-lift trucks, labor requirements per 1,000 boxes by wheel conveyors are no greater to move empty boxes to the packing line than with monorail conveyors. The labor necessary to place boxes on a wheel conveyor or to hook them on a monorail conveyor does not differ greatly, therefore, the amount of time required for each operation is assumed to be the same. Although labor requirements are the same, there is a difference in equipment costs.

Comparison of Methods and Types of Equipment for Moving Empty Boxes from Storage to the Packing Line

Moving empty boxes from storage to the packing line by clamp-type 2-wheel hand trucks in combination with monorail or wheel conveyors is less expensive than by fork-lift trucks and pallets in combination with conveyors (table 8). Furthermore, the cost of using wheel conveyors is less than the cost of using monorail conveyors. The difference in cost of using the two types of conveyors under the current wage-rate assumption amounts to $0.72 per 1,000 boxes, and is due to costs of equipment. Even though fork-lift-truck methods are more expensive than the hand-truck methods, and monorail conveyors are more expensive than wheel conveyors, these costs are not the only factors that should enter into the determination of which method to use for handling empty containers. If equipment is already on hand for use in handling fruit, it also may be desirable to use this equipment to handle empty boxes. In addition, the convenience of the monorail conveyor for handling different types of packages at the same time also should be considered.

Table 8.--Comparative labor and equipment costs for moving 1,000 empty boxes from storage to the packing line, by 4 specified methods

Method	Workers	Labor and equipment required		Labor and equipment costs			
		Equipment time 1/	Total labor	Equipment	Labor 2/	Total cost	
						Current wages	Assumed wages
	Number	Machine-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
18-box unit loads hand trucked by worker 50 feet from temporary storage to monorail conveyor. Worker hangs empty boxes on monorail conveyor.	1	3/ 6.72	1.96	1.48	2.25	3.73	4.22
72-box pallet loads moved by fork-lift truck 50 feet from temporary storage to monorail conveyor. Second worker hangs empty boxes on monorail conveyor.	2	4/ 5.24	1.65	2.30	1.93	4.23	4.64
18-box unit loads hand trucked by worker 50 feet from temporary storage to wheel conveyor. Worker places boxes on and pushes them down wheel conveyor.	1	5/ 6.72	1.96	.76	2.25	3.01	3.50
72-box pallet loads moved from temporary storage by fork-lift truck 50 feet to wheel conveyor. Second worker places boxes on and pushes them down wheel conveyor.	2	6/ 5.24	1.65	1.58	1.93	3.51	3.92

1/ Conveyor equipment time used is based on the assumption that 210 boxes per hour are needed at the packing line.
2/ Computed from current wage rates.
3/ 300-foot monorail conveyor 4.76 machine-hours, clamp-type 2-wheel hand truck 1.96 machine-hours, total 6.72 machine-hours.
4/ 300-foot monorail conveyor 4.76 machine-hours, 4,000-pound capacity electric industrial fork-lift truck 0.24 machine-hours, 13.9 pallets (40- by 48-inch) 0.24 machine-hour, total 5.24 machine-hours.
5/ 200-foot gravity wheel conveyor 4.76 machine-hours, clamp-type 2-wheel hand truck 1.96 machine-hours, total 6.72 machine-hours.
6/ 200-foot gravity wheel conveyor 4.76 machine-hours, 4,000-pound capacity electric fork-lift truck 0.24 machine-hours, 13.9 pallets (40- by 48-inch) 0.24 machine-hour, total 5.24 machine-hours.

METHODS AND EQUIPMENT FOR MOVING EMPTY BOXES FROM THE DUMPING AREA AT THE BEGINNING OF THE WASHING AND PACKING LINE TO STORAGE

A common practice in Washington State apple packing and storage houses is to pack apples into the same boxes from which loose fruit has been dumped. Exceptions are plants that use cartons for shipping containers and plants that use a special field container. In plants that pack apples in the boxes from which loose fruit is dumped, there is an accumulation of extra boxes because one-third fewer boxes are required for packed fruit than for loose fruit. These extra boxes must be moved from the dumping area to storage.

Empty boxes usually are moved from the dumping area to storage by clamp-type 2-wheel hand trucks alone or fork-lift trucks and pallets. Occasionally they are moved by belt conveyors in combination with clamp-type 2-wheel hand trucks. The worker who dumps the fruit nests the empty boxes in 3-box units and stacks the units 6 high either on pallets or in single stacks beside his station (fig 18). After stacks are built, empty

Figure 18.--Dumper nesting empty boxes. Three-box units are stacked 6 boxes high, either on pallets or in stacks for hand trucks.

boxes usually are set aside near the dumping area in a temporary bank of supply. Later they are moved to permanent storage. For the purposes of analysis it is assumed that a transportation distance of 40 feet is

required to move the boxes from the dumping area into temporary storage position and 110 feet to move them to final storage.

Clamp-Type 2-Wheel Hand Truck

The method of moving empty boxes from the dumping area by the clamp-type 2-wheel hand truck requires only 1 worker to move fruit into the temporary bank (fig. 19). As boxes accumulate slowly, 1 worker is adequate. It is assumed that when this worker is not productively occupied by this task, his time is utilized by performing other jobs. Otherwise the worker waits a considerable part of the time. When the stacks of empty boxes are moved to final storage 110 feet away, 3 hand truckers are used. Empty boxes usually are not tiered or piled high in storage rooms unless there is an unusually large number of boxes to be stored.

Figure 19.--An 18-box load of empty boxes being moved from dumping area to temporary storage by clamp-type 2-wheel hand truck.

By this method 1.52 man-hours of labor are required to move 1,000 empty boxes from dumping area to storage (table 9). Nearly one-third of this labor is used in moving fruit from the dumping station to temporary storage position.

Industrial Fork-Lift Truck and Pallets

When fork-lift trucks and pallets are used to move empty boxes to storage, it is assumed, as with the clamp-type 2-wheel hand-truck method, that a fork-lift truck picks up pallet loads of empty boxes in the dumping area and moves them 40 feet to temporary storage. Later pallet loads are moved 110 feet to permanent storage. It also is assumed that the time of the fork-lift truck operator is fully occupied by assignment to other work when he is not productively engaged in these operations. Under this assumption only the time actually used in moving empty boxes from dumping area to storage is charged against the operation. The work of both the man who dumps fruit and that of the operator of the fork-lift truck proceeds more smoothly if gravity-type conveyors or roller dollies are used to accumulate more than

Table 9.--Labor required for a 3-man crew to move 1,000 empty boxes from the dumping area to storage by clamp-type 2-wheel hand trucks

Operation	Workers	Productive time	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours
Pick up 18-box loads of empty boxes by clamp-type 2-wheel hand truck at conveyor (open area)	1	0.09	0.0	0.09
Transport 18-box loads 40 feet to temporary bank	1	.29	.0	.29
Release 18-box loads at temporary storage (crowded area)	1	.11	.0	.11
Pick up 18-box loads at temporary storage by clamp-type 2-wheel hand trucks (crowded area)	3	.11	.0	.11
Transport 18-box loads 110 feet by clamp-type 2-wheel hand trucks from temporary bank to storage area	3	.74	1/ .05	.79
Release 18-box loads in storage area (congested crowded area)	3	.13	.0	.13
Total man-hours	-	1.47	.05	1.52

1/ Caused by crew interference.

Figure 20.--Pallet loads of empty boxes are accumulated on roller dollies.

1 pallet load of empty boxes at a time (fig. 20). But the use of the conveyors or dollies has little effect on labor requirements and only little extra expense is involved.

Labor required to move 1,000 empty boxes from the dumping area to storage by fork-lift truck and pallets amounted to 0.50 man-hour (table 10). This is only one-third of the labor required by the method using the clamp-type 2-wheel hand truck.

Table 10.--Labor required for 1 worker to move 1,000 empty boxes from the dumping area to storage by fork-lift truck and pallets

Operation	Workers	Productive time	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours
Pick up 72-box pallet load by fork-lift truck at dumping area	1	0.03	0.0	0.03
Transport 72-box pallet load 40 feet by fork-lift truck to temporary bank	1	.14	.0	.14
Release 72-box pallet load at temporary storage	1	.03	.0	.03
Pick up 72-box pallet load by fork-lift truck at temporary storage area	1	.03	.0	.03
Transport 72-box pallet load 110 feet by fork-lift truck to storage room	1	.21	.0	.21
Release load in storage (average 1st, 2d, and 3d tiers)	1	.06	.0	.06
Total man-hours	-	.50	.0	.50

Belt Conveyor in Combination with Clamp-Type 2-Wheel Hand Truck

In a few plants empty boxes are moved from the dumping area to storage by belt conveyors in combination with clamp-type 2-wheel hand trucks. All these plants operate 2 or more packing lines. In this method a belt conveyor is installed to run overhead in front of a mechanical dumper or a worker who dumps fruit (fig 21). This worker, after dumping the fruit, places the empty boxes on the belt conveyor which moves them to storage. For comparative purposes it is assumed that the boxes are conveyed 75 feet by the belt conveyor to a work table where they are removed by a worker who also builds the boxes into units of 3 boxes each and stacks them 6 high (fig. 22). They are then moved by hand truck to a storage position 75 feet away.

Moving empty boxes from the dumping area to storage by belt conveyor in combination with clamp-type 2-wheel hand trucks requires 2.40 man-hours per 1,000 boxes (table 11). Of the total labor, 70 percent is used in removing the boxes from the belt conveyor, nesting them in groups of 3, and stacking them 6 high. In this operation some wait time occurs because

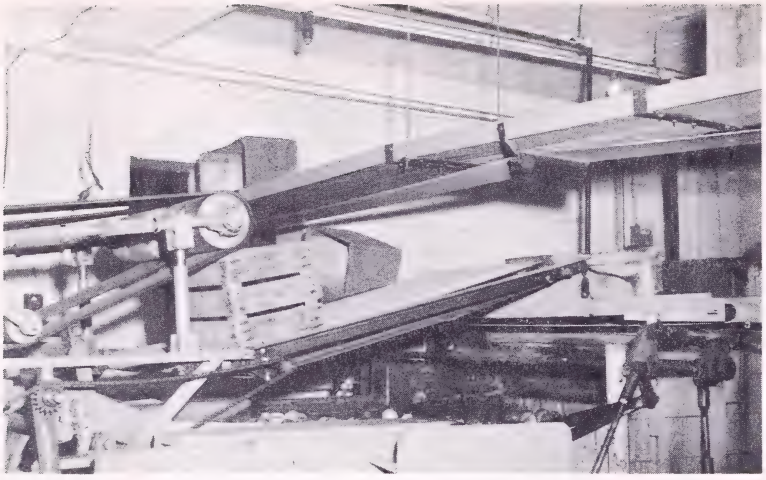

Figure 21.--A mechanical dumper feeding empty boxes onto a belt conveyor which moves them to the storage room.

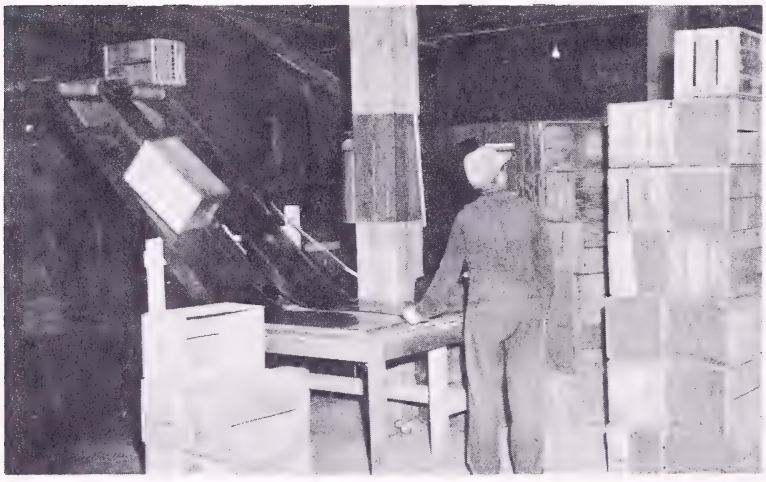

Figure 22.--Worktable to which boxes are carried by a belt conveyor. On arrival at this table, boxes are removed, nested, and stacked 6 high.

the worker removing the boxes from the belt does not receive the boxes at a fast enough rate to keep him fully occupied. It is assumed that the worker performing the hand-trucking operation is transferred to other work when not productively employed in handling empty boxes, so no wait time on his part occurs.

Table 11.--Labor required for a 2-man crew to move 1,000 empty boxes from the dumping area to storage by a belt conveyor and clamp-type 2-wheel hand trucks

Operation	Workers	Productive time	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours
Nest (at work table) empty boxes into 3-box units and stack them into 18-box unit loads on floor	1	1.25	0.42	1/ 1.67
Pick up 18-box load at work table by clamp-type 2-wheel hand truck (open area)	1	.09	.0	.09
Transport 18-box load 75 feet to storage	1	.51	.0	.51
Release load in storage room (congested area)	1	.13	.0	.13
Total man-hours	-	1.98	.42	2.40

1/ Assuming worker receives boxes from 2 packing lines where the rate of dumping for each line is 300 boxes per hour.

Comparison of Methods and Equipment for Moving Empty Boxes from the Dumping Area to Storage

Of the 3 methods of moving empty boxes from the dumping area to storage the use of hand trucks is the most economical. The hand-truck method incurs labor and equipment costs of $1.79 per 1,000 boxes compared with $3.66 by belt conveyor in combination with the clamp-type 2-wheel hand trucks (table 12). Labor costs are lowest by fork-lift trucks--only $0.65 per 1,000 boxes. Where the labor factor is relatively important the fork-lift truck method would probably be best, but the decision to use fork-lift trucks would depend primarily on whether or not a plant has found fork-lift trucks to be desirable for other materials-handling operations. Handling only empty containers by fork-lift trucks and pallets could not be justified because of fairly high cost of the equipment. The equipment costs would need to be shared by other operations.

Table 12.--Comparative labor and equipment costs for moving 1,000 empty boxes from the dumping area to storage, by 3 specified methods

Method	Workers	Labor and equipment required			Labor and equipment costs			
		Equipment time	Wait time	Total labor	Equipment	Labor 1/	Total cost: Current wages	Total cost: Assumed wages
	Number	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
1 worker hand trucks 18-box loads 40 feet from dumping area to temporary storage. Later, 3 workers hand-truck boxes 110 feet to storage.	3	2/ 1.52	0.05	1.52	0.04	1.75	1.79	2.17
1 fork-lift truck operator moves 72-box pallet loads 40 feet from dumping area to temporary storage. Later, fork-lift truck operator moves pallet loads 110 feet to storage.	1	3/ 1.00	.0	.50	1.82	.65	2.47	2.60
Boxes moved by belt conveyor 75 feet from dumping area to worktable. One worker nests boxes into 3-box units and builds loads 6 high for hand trucker. One worker hand-trucks 18-box loads 75 feet to storage.	2	4/ 4.06	.42	2.40	.90	2.76	3.66	4.26

1/ Computed from current wage rates.
2/ Clamp-type 2-wheel hand trucks only.
3/ 4,000-pound capacity electric fork-lift truck requiring 0.50 machine-hour, and 13.9, 40- by 48-inch, pallets requiring 0.50 machine-hour or a total of 1.00 machine-hour.
4/ 75-foot belt conveyor 3.33 machine-hours, clamp-type 2-wheel hand truck 0.73 machine-hour, total 4.06 machine-hours.

METHODS AND EQUIPMENT FOR MOVING EMPTY BOXES FROM THE DUMPING AREA TO BOX-HOUSE STORAGE BY USE OF ROAD TRUCKS OR ORCHARD TRAILERS

Road trucks and orchard trailers frequently are used to haul empty boxes from the packinghouse to permanent storage in box houses, particularly at the conventional-type plants where industrial trucks are not used. Plants using fork-lift trucks and pallets apparently find it more desirable to store empty boxes on pallets in a cold-storage room or outside in an open area rather than in box houses (fig. 23).

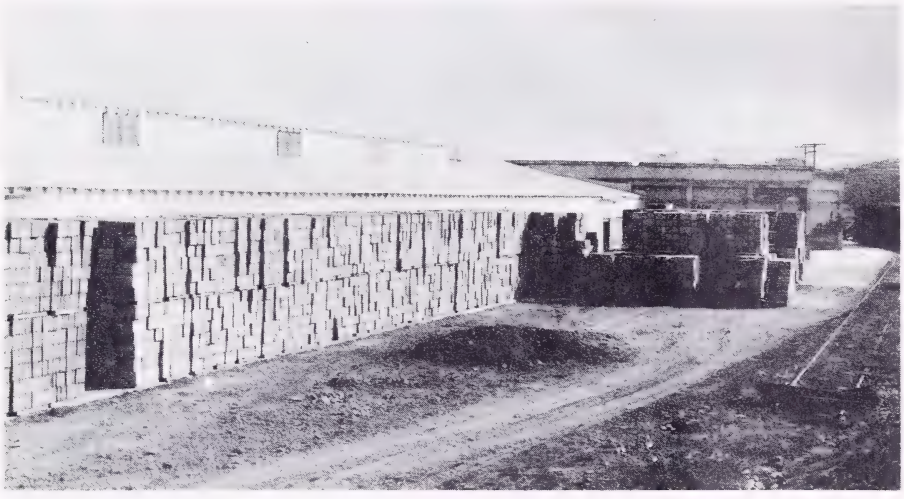

Figure 23.--Pallet loads of 72 empty boxes stored near a warehouse.

In moving empty boxes by road trucks or orchard trailers, from the dumping area to box houses for storage, the loading of trucks and trailers is accomplished by clamp-type 2-wheel hand trucks. One worker hand-trucks 18-box unit loads from the dumping area to a temporary bank. Other workers hand-truck these unit loads from the temporary storage bank into position on the truck or trailer bed (fig. 24). The carrier is then driven to the location selected for the box house, where 3-box units are handed from worker to worker and finally placed into the box house (fig. 25.)

Figure 24.--Hand-trucking 18-box stacks of empty boxes into position on an orchard trailer.

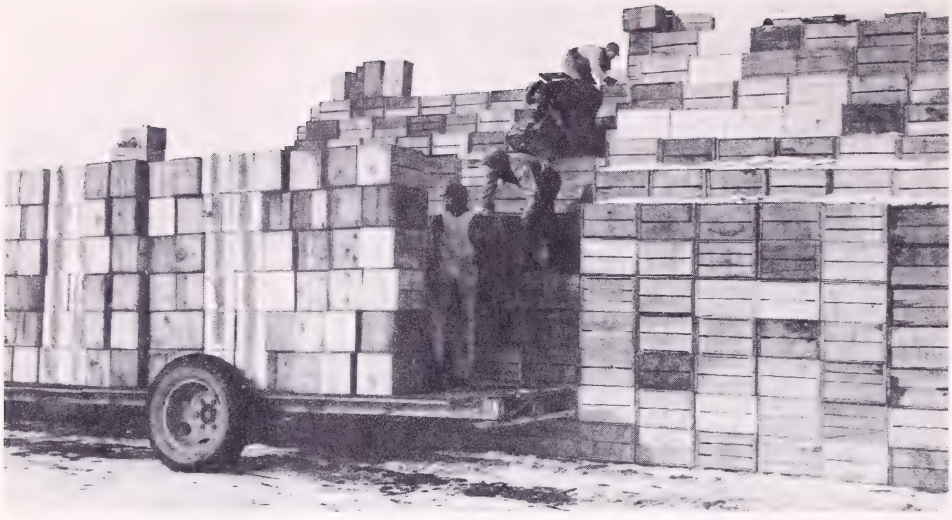

Figure 25.--Moving 3-box units of empty boxes from an orchard trailer into a box house.

For purposes of this analysis it is assumed that 1 worker hand-trucks 18-box stacks from the dumping area to the temporary storage position, a distance of 40 feet. As the worker's time is not completely occupied in performing this task, his extra time is chargeable against other operations to which he is assigned. When the orchard trailer or road truck is in a position for loading, 2 workers hand-truck the boxes 30 feet from the temporary bank onto the vehicle. When the vehicle arrives at the box house, 3 men remove the boxes from the trailer or truck and place them in final storage position. The operation of building the box house is the reverse of tearing it down. There are a number of variations in the method of building the house; some workers stand on the ground or truck, the remainder at various heights on the box house.

Total labor required to move 1,000 empty boxes from the dumping area to box-house storage is 4.49 man-hours, when the boxes are moved by clamp-type 2-wheel hand trucks from the dumping area to temporary storage and from temporary storage to position on an orchard trailer or road truck, and are unloaded from the trailer or truck and manually placed in a box house by a 3-man crew (table 13). The time required to move the trailer or road truck between the packinghouse and box house is not included.

Most of the labor required for moving boxes to box-house storage--about 57 percent--is used in building the box house. The small amount of wait time involved in building the box house and a small amount of time lost because of crew interference in hand trucking from temporary storage to the orchard trailer or road truck bring the total wait time to 0.37 man-hour, about 8 percent of the total labor.

Table 13.--Labor required for a 3-man crew to move 1,000 empty boxes from the dumping area to box-house storage by clamp-type 2-wheel hand truck and manual method, when trucks and orchard trailers are used to cart boxes from the packinghouse to the box house 1/

Operation	Workers	Productive time	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours
Pick up 18-box loads at dumping area by clamp-type 2-wheel hand truck (open area)	1	0.09	0.0	0.09
Transport loads 40 feet from dumping area to temporary storage	1	.29	.0	.29
Release loads at temporary storage (crowded area)	1	.11	.0	.11
Pick up 18-box loads at temporary storage by clamp-type 2-wheel hand trucks (crowded area)	2	.11	.0	.11
Transport 30 feet to road truck	2	.23	2/ .03	.26
Release loads on road truck or trailer bed (crowded area)	2	.11	.0	.11
Manually unload box units from truck or trailer and place them in box house	3	2.23	.34	2.57
Put on box house roof	3	.95	.0	.95
Total man-hours	-	4.12	.37	4.49

1/ Labor requirements shown do not include transit time of workers between the packinghouse and box house.
2/ Crew interference.

At current wage rates, labor and equipment costs for moving 1,000 empty boxes from the dumping area to the storage point and building the box house are $5.18. Equipment use accounts for only a very small part of these costs as the operation is almost completely manual (table 14). The cost of the road truck or the orchard trailer is not included.

Table 14.--Labor and equipment costs for moving 1,000 empty boxes from the dumping area to box-house storage by clamp-type 2-wheel hand truck and manual method, when road trucks and orchard trailers are used to cart boxes from packinghouse to box house

Method	Workers	Labor and equipment required: Equipment time	Wait time	Total labor	Labor and equipment costs: Equipment	Labor 1/	Total cost: Current wages	Assumed wages
	Number	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
1 worker hand-trucks 18-box loads 40 feet from dumping area to temporary storage. Two men hand-truck loads 30 feet to truck or trailer. Three men unload truck or trailer to box pile.	3	2/ 0.97	0.37	4.49	0.02	5.16	5.18	6.31

1/ Computed from current wage rates.
2/ Clamp-type 2-wheel hand truck only.

COMPARISON OF COMBINATIONS OF TYPES OF MATERIALS-HANDLING EQUIPMENT USED FOR HANDLING EMPTY BOXES

Comparative labor and equipment requirements and their costs for handling 1,000 empty boxes through 3 specified cycles of operations by the materials-handling methods discussed, are shown in table 15. The 3 cycles of operations are: (1) Moving empty boxes from storage and loading them on road trucks and orchard trailers; (2) moving empty boxes from storage to packing line; and (3) moving empty boxes from dumping area to storage. Costs for the 3 cycles of operations have been combined for the methods that might be used by plants equipped with certain types of equipment. These groupings are: (1) Manual labor and clamp-type 2-wheel hand truck; (2) clamp-type 2-wheel hand truck; and (3) industrial fork-lift truck and pallets. As these groupings are somewhat arbitrary, an individual plant operator should recombine the data for the operations as performed in his plant before deciding to shift to other methods. One of the major factors that should be considered by plant operators in selecting the type of equipment for handling empty boxes is its potential efficiency for fruit-handling operations. For example, a plant operator should not invest funds in costly equipment for handling only empty containers if other equipment is used for handling unpacked and packed boxes of fruit.

Labor and equipment costs are lowest for handling 1,000 empty boxes through the 3 cycles of operations when clamp-type 2-wheel hand trucks are used, the total cost being $6.15. When industrial fork-lift trucks and pallets are used, these costs are increased to $8.22 per 1,000 empty boxes even though the labor costs are the lowest of the 3 equipment combinations. Manual handling at the box house combined with the use of clamp-type 2-wheel hand trucks increases the costs for performing these 3 cycles of operations to $11.63 per 1,000 empty boxes, or $5.48 above the lowest cost method.

According to these figures, the clamp-type 2-wheel hand truck has the advantage over other types of equipment by a fairly wide margin. But this advantage decreases as the cost of labor increases and, at a wage rate of $0.25 per hour above the current wage rate, the advantage of the hand truck is reduced to $1.65 per 1,000 empty boxes handled.

☆ U. S. GOVERNMENT PRINTING OFFICE : 1954 O - 304219

Table 15.--Comparative labor and equipment costs for handling 1,000 empty boxes through 3 specified cycles of operations, by use of specified types and combinations of types of equipment 1/

Type of equipment and cycles of operations	Workers	Labor and equipment required		Labor and equipment costs			
		Equipment	Labor	Equipment 2/	Labor 3/	Total cost: Current wages 3/	Total cost: Assumed wages 4/
	Number	Machine-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Manual labor and clamp-type 2-wheel hand truck:							
Moving from storage and loading onto road trucks and orchard trailers (manually) 5/	5	0.0	2.99	0.00	3.44	3.44	4.19
Moving from storage to packing line (hand trucks and wheel conveyor)	1	6.72	1.96	.76	2.25	3.01	3.50
Moving from dumping area to storage by use of road trucks or orchard trailers (hand truck and manually) 6/	3	.97	4.49	.02	5.16	5.18	6.31
Totals (3 cycles of operations)	9	7.69	9.44	.78	10.85	11.63	14.00
Clamp-type 2-wheel hand truck:							
Moving from storage and loading onto road trucks and orchard trailers	3	1.15	1.15	.03	1.32	1.35	1.64
Moving from storage to packing line:							
In combination with gravity wheel conveyor	1	6.72	1.96	.76	2.25	3.01	3.50
In combination with monorail conveyor	1	6.72	1.96	1.48	2.25	3.73	4.22
Moving from dumping area to storage:							
Clamp-type 2-wheel hand trucks alone	3	1.52	1.52	.04	1.75	1.79	2.17
In combination with belt conveyor	2	4.06	2.40	.90	2.76	3.66	4.26
Totals (3 cycles of operations) 7/	7	9.39	4.63	.83	5.32	6.15	7.31
Industrial fork-lift truck and pallets:							
Moving from storage and loading onto road trucks and orchard trailers	2	.66	.80	1.20	1.04	2.24	2.44
Moving from storage to packing line:							
In combination with gravity wheel conveyor	2	5.24	1.65	1.58	1.93	3.51	3.92
In combination with monorail conveyor	2	5.24	1.65	2.30	1.93	4.23	4.64
Moving from dumping area to storage	1	1.00	.50	1.82	.65	2.47	2.60
Totals (3 cycles of operations) 7/	5	6.90	2.95	4.60	3.62	8.22	8.96

1/ Except as otherwise noted, transportation distances have been standardized as follows: (1) Moving from storage and loading onto road trucks 100 feet; (2) moving from storage to packing line 250 feet (including 200 feet by conveyor); and (3) moving from dumper to storage 150 feet.

2/ Equipment costs computed from data on ownership and operating costs shown in table 1.

3/ Current labor costs computed from wage rates of $1.15 per hour for unskilled labor and $1.30 per hour for semiskilled workers (key workers such as industrial truck operators).

4/ Assumed labor costs computed from wage rates of $1.40 per hour for unskilled labor and $1.55 per hour for semiskilled workers.

5/ Actually no transportation distance is involved except the distance moved in passing the boxes from worker to worker.

6/ Transportation distance to load the road trucks is 70 feet. In unloading trucks the same condition holds as in footnote 5.

7/ Where 2 methods are shown for performing a given cycle of operations, the lower cost method is the one included in the total.

APPENDIX

Standard Data

Average labor requirements per 1,000 empty boxes for performing handling operation by different types and combinations of types of materials-handling equipment

	Base time Man-hours	Fatigue allowance Man-hours	Productive time Man-hours
Setup and cleanup when loading empty boxes on road truck or orchard trailer. Setup begins when the truck driver starts to remove the tie ropes, end gates, or V-boards from the road truck or orchard trailer. Consists of removing tie ropes, end gates, or V-boards; placing bridge plate when necessary; obtaining handling equipment if used; and when manual handling is performed the time of workers to get into position. Ends when the vehicle is ready to receive empty boxes. Cleanup begins when the last box, stack, or pallet load has been put into position. Consists of moving materials-handling equipment to temporary storage; removing bridge plate; placing end gates, or V-boards in position on vehicle; and tying down the load. Ends when the truck driver walks toward the cab of the road truck or toward the tractor.	0.14	-	0.14
Setup and cleanup when unloading empty boxes from road truck or orchard trailer. Setup begins when the truck driver starts to remove the tie ropes, end gates, or V-boards from the road truck or orchard trailer. Consists of removing the tie ropes, end gates, or V-boards; placing bridge plate when necessary; obtaining handling equipment if used; and when manual handling is performed, the time of workers to get into position. Ends when the vehicle is ready to be unloaded. Cleanup begins when the last box, stack, or pallet load has been removed from the vehicle. Consists of moving materials-handling equipment to temporary storage; removing bridge plate; placing end gates or V-boards in position on vehicle; and tying ropes. Ends when the truck driver walks toward the cab of the road truck or toward the tractor.	.08	-	.08
Manually load boxes from box house to road truck or orchard trailer by passing 3-box units from 1 worker to another until the empty boxes are stacked on the truck bed.	1.77	0.18	1.95
Take the roof, made of 1- by 10-inch or 1- by 12-inch boards, off box house. Consists of prying boards free from boxes, removing nails from boards, and placing boards in stacks.	.36	.04	.40
Take new empty boxes from stacks placed near a monorail conveyor and hang them on the conveyor.	1.28	.13	1.41
Take empty field boxes from a monorail conveyor, nest into 3-box units, and stack near conveyor.	1.14	.11	1.25
Take empty field boxes from a monorail conveyor, nest into 3-box units, stack near conveyor, and take new empty boxes from stacks near conveyor and hang on conveyor.	1.29	.13	1.42
Take empty field boxes from a monorail conveyor, nest into 3-box units, stack near conveyor, take new empty boxes from stacks near conveyor, and hang them on conveyor, and move all stacks (18 boxes) by clamp-type 2-wheel hand truck an average distance of 25 feet.	1.68	.17	1.85
Take boxes delivered to work table from dumper (automatic or manual) by belt conveyor, nest into 3-box units and stack 6 units high (18 boxes) for hand trucking.	1.14	.11	1.25
Take boxes delivered to a gravity roller conveyor from dumper (automatic or manual) by belt conveyor, nest into 3-box units, and stack 6 units high (18 boxes) near conveyor for hand trucking. Includes time to move along the roller conveyor to reach boxes.	1.51	.15	1.66
Manually unload boxes from road truck or orchard trailer by passing 3-box units from 1 worker to another until the empty boxes are stacked in the box house.	2.03	.20	2.23
Put the roof, made of 1- by 10-inch or 1- by 12-inch boards, on a box house. Consists of taking the boards from stacks, placing them on the box house, and nailing the boards to the boxes.	.86	.09	.95

Average labor requirements per 1,000 empty boxes for performing handling operations by use of clamp-type 2-wheel hand trucks

	Base time Man-hours	Fatigue allowance Man-hours	Productive time Man-hours
Pick up 18-box loads by use of clamp-type 2-wheel hand trucks: 1/			
In crowded area where surrounding stacks of boxes make maneuvering necessary, or where lack of space between stacks does not permit the clamps of the hand truck to enter conveniently (for example, in storage).	0.13	0.01	0.14
In relatively crowded area where boxes were originally placed in position by hand truck or stacked with adequate spacing between stacks for clamps to enter (for example, beside belt conveyor or in storage).	.10	.01	.11
In an open area with sufficient room for easy maneuvering (for example, beside belt or in open at dumping area).	.08	.01	.09
Transport 18-box loads by use of clamp-type 2-wheel hand trucks and return the truck empty: 2/			
One-way distance:			
10 feet	.09	.01	.10
15 feet	.12	.01	.13
20 feet	.15	.02	.17
25 feet	.18	.02	.20
30 feet	.21	.02	.23
40 feet	.26	.03	.29
50 feet	.32	.03	.35
60 feet	.38	.04	.42
70 feet	.44	.04	.48
80 feet	.49	.05	.54
90 feet	.55	.06	.61
100 feet	.61	.06	.67
125 feet	.75	.08	.83
150 feet	.89	.09	.98
175 feet	1.03	.10	1.13
200 feet	1.18	.12	1.30
225 feet	1.32	.13	1.45
250 feet	1.46	.15	1.61
Release 18-box loads by use of clamp-type 2-wheel hand trucks: 3/			
In crowded area where surrounding stacks of boxes make maneuvering necessary (for example, stacks placed in storage position).	.12	.01	.13
In relatively crowded area (for example, on road truck bed).	.10	.01	.11
In an open area with sufficient room for easy maneuvering (for example, beside belt, gravity roller, or monorail conveyors).	.08	.01	.09

1/ Work performed by a worker in picking up a load by use of clamp-type 2-wheel hand truck. Begins when worker starts to position hand truck for the pickup or when the clamps pass the front of the load, ends when the hand truck begins forward motion.

2/ Work performed by a worker in moving unit loads of 18 boxes from pickup point to point of release and returning the truck empty. Transport time for round trip based on the following formula: $t = 0.0057d + 0.036$, where d = distance in feet from pickup point to release point and t = time in man-hours per 1,000 boxes to transport the truck loaded and return it empty.

3/ Work performed by a worker in releasing a load by use of a clamp-type 2-wheel hand truck. Begins when forward motion ends or when maneuvering for release begins, ends when the hand truck begins forward motion to return empty.

Average labor requirements per 1,000 empty boxes for performing handling operations by use of a 4,000-pound capacity electric industrial fork-lift truck 1/

	Base time Man-hours	Fatigue allowance Man-hours	Productive time Man-hours
Pick up 72-box pallet loads of empty boxes by use of industrial fork-lift truck: 2/			
From road truck or orchard trailer bed	0.04	0.0	0.04
From floor level surface	.03	.0	.03
From storage area stack (average of 1st, 2d, and 3d tiers)	.06	.0	.06
Transport 72-box loads of empty boxes by use of industrial fork-lift truck and return empty: 3/			
One-way distance:			
5 feet	.03	.0	.03
10 feet	.04	.0	.04
20 feet	.08	.0	.08
31 feet	.12	.01	.13
40 feet	.13	.01	.14
50 feet	.14	.01	.15
60 feet	.15	.01	.16
70 feet	.16	.01	.17
80 feet	.17	.01	.18
90 feet	.18	.01	.19
100 feet	.19	.01	.20
125 feet	.22	.01	.23
150 feet	.25	.01	.26
200 feet	.30	.02	.32
250 feet	.35	.02	.37
300 feet	.40	.02	.42
350 feet	.45	.02	.47
400 feet	.50	.02	.52
500 feet	.61	.03	.64
Over 500 feet	4/		
Release 72-box pallet loads of empty boxes by use of industrial fork-lift truck:			
On road truck or orchard trailer bed	.07	.0	.07
On floor level surface	.025	.0	.025
In storage area (average of 1st, 2d, and 3d tiers)	.06	.0	.06

1/ These handlings are performed in 72-box pallet loads on 40- by 48-inch or 40- by 36-inch pallets.

2/ Work performed by a worker in picking up a load by use of an industrial fork-lift truck. Begins when the fork-lift truck operator starts to maneuver for pickup or when the forks pass the front of the load, consists of raising the load, ends when pallet clears original position.

3/ Work performed by industrial fork-lift truck operator in transporting pallet loads of 72 boxes from pickup point to point of release and returning empty. Transport time for round trip based on the following formulas: $t = 0.0027d + 0.009$ (for distances from 0 through 30 feet), $t = 0.00103d + 0.09$ (for distances 31 feet and above), where d = distance in feet from pickup point to release point, and t = time in man-hours per 1,000 boxes to transport loaded and return empty.

4/ Work performed by a worker in releasing a load by use of industrial fork-lift truck. Begins when the forward motion of the industrial fork-lift truck stops or when maneuvering for release starts, consists of setting the load in position, ends when the forks are withdrawn from the pallets.